



RECEIVED  
NOV 19 2003  
TC 1700

Circle Only One Area of Technology  
Applicable to this Invention

REC'D [REDACTED]  
0005545

ETCH/SiC  
0916

AIT	AKT/TFT	CMP	CVET/CORP
DCVD	EMET	EPI/HTF	ESHO
HCVD	MCVD	MICR	<u>HDP ETCH</u>
PLAT	PVD	RTP	

### INVENTION ALERT FORM

(Please use separate attachments for any answers that don't fit on the form, especially for questions 6-8. If the answer to a question is "none", please write "none" rather than leaving the answer blank.)

1. Today's date: [REDACTED]
2. Title of Invention: HIGH HARD MASK SELECTIVITY TUNGSTEN  
ETCH USING  $\text{NF}_3/\text{C}_6\text{H}_6$  CHEMISTRY
3. Provide the following information for EACH inventor:

#### Inventor #1

Name: Gene H. Lee  
Telephone: (408) 437-9515 (hm) (408) 584-0269 (business)  
Job Title: Process Engineer  
Citizenship: U.S.  
Home Address: 1241 Briarleaf Cir, S.J. 95131  
Boss's Name: Nam-Hun Kim  
Boss's Job Title: Sr Engineering Manager  
His/Her Boss's Name: Dragan Podlesnik  
His/Her Boss's Job Title: General Manager  
Product Group: Silicon Etch

Inventor #2

Name: NAM-HUN KIM  
Telephone: 408-584-0225  
Job Title: Sr. Eng. Mgr  
Citizenship: Korea  
Home Address: 7767 Lilac Way, Cupertino, CA 95014  
Boss's Name: Dragan Podlesnik  
Boss's Job Title: General Mgr of Silicon Etch  
His/Her Boss's Name: Kevin Fairbairn  
His/Her Boss's Job Title: VP  
Product Group: Silicon Etch

Inventor #3

Name: \_\_\_\_\_  
Telephone: \_\_\_\_\_  
Job Title: \_\_\_\_\_  
Citizenship: \_\_\_\_\_  
Home Address: \_\_\_\_\_  
Boss's Name: \_\_\_\_\_  
Boss's Job Title: \_\_\_\_\_  
His/Her Boss's Name: \_\_\_\_\_  
His/Her Boss's Job Title: \_\_\_\_\_  
Product Group: \_\_\_\_\_

Inventor #4

Name: \_\_\_\_\_  
Telephone: \_\_\_\_\_  
Job Title: \_\_\_\_\_  
Citizenship: \_\_\_\_\_  
Home Address: \_\_\_\_\_  
Boss's Name: \_\_\_\_\_  
Boss's Job Title: \_\_\_\_\_  
His/Her Boss's Name: \_\_\_\_\_  
His/Her Boss's Job Title: \_\_\_\_\_  
Product Group: \_\_\_\_\_

Inventor #5

Name: \_\_\_\_\_  
Telephone: \_\_\_\_\_  
Job Title: \_\_\_\_\_  
Citizenship: \_\_\_\_\_  
Home Address: \_\_\_\_\_  
Boss's Name: \_\_\_\_\_  
Boss's Job Title: \_\_\_\_\_  
His/Her Boss's Name: \_\_\_\_\_  
His/Her Boss's Job Title: \_\_\_\_\_  
Product Group: \_\_\_\_\_

Inventor #6

Name: \_\_\_\_\_  
Telephone: \_\_\_\_\_  
Job Title: \_\_\_\_\_  
Citizenship: \_\_\_\_\_  
Home Address: \_\_\_\_\_  
Boss's Name: \_\_\_\_\_  
Boss's Job Title: \_\_\_\_\_  
His/Her Boss's Name: \_\_\_\_\_  
His/Her Boss's Job Title: \_\_\_\_\_  
Product Group: \_\_\_\_\_

Inventor #7

Name: \_\_\_\_\_  
Telephone: \_\_\_\_\_  
Job Title: \_\_\_\_\_  
Citizenship: \_\_\_\_\_  
Home Address: \_\_\_\_\_  
Boss's Name: \_\_\_\_\_  
Boss's Job Title: \_\_\_\_\_  
His/Her Boss's Name: \_\_\_\_\_  
His/Her Boss's Job Title: \_\_\_\_\_  
Product Group: \_\_\_\_\_

4. Earliest dates and model names of all Applied products incorporating the invention which have been offered for sale or are expected to be offered for sale

DPS poly-etch chamber

5. If invention has been demonstrated or described to persons other than Applied employees, for each disclosure please provide the earliest date, name of company, and brief description of what information was disclosed and purpose of the disclosures.

Hyundai - process chemistry was disclosed for demo update

Samsung - process recipe was disclosed to resolve process tuning issues

6. If disclosures as in question (4) are expected to occur within the next 12 months, please provide the anticipated date, type of information, and purpose of the disclosure.

NONE

7. Describe the invention, preferably with reference to drawings.

A novel recipe has been developed to anisotropically etch tungsten film while maintaining higher selectivity to Nitride ( $\text{Si}_3\text{N}_4$ ) hardmask than other typical fluorine based chemistries. The challenges of etching tungsten are producing vertically etched profiles with no CD gain or re-entrant profile, while maintaining high selectivity to Nitride mask. With  $\text{NF}_3/\text{Cl}_2$  based chemistry, typical selectivity to  $\text{Si}_3\text{N}_4$  mask is  $>2.5:1$ . Using other F-based chemistries (at low temperatures) the  $\text{W}:\text{Si}_3\text{N}_4$  selectivity is  $<1:1$ . If  $\text{Si}_3\text{ON}$  (Silicon oxy-nitride) mask is used, then the selectivity can be higher with  $\text{NF}_3/\text{Cl}_2$  based chemistry.

A proper ratio of  $\text{NF}_3$  gas to  $\text{Cl}_2$  gas will provide the necessary reactants to remove the tungsten film while providing passivation on the tungsten sidewall to prevent lateral etch.

The patterned tungsten film can be used as conducting material for transistor gates and DRAM bit-line applications.

Nitride mask	$\text{Si}_3\text{N}_4$
Tungsten	W



## # 8

The challenge of etching tungsten film at standard gate process temperatures (~50C), is to achieve vertical profiles with no line width (active area) gain.

### 1) High W:Nit selectivity:

Etching with other fluorine based chemistries (ie: CF<sub>4</sub>, CF<sub>4</sub>/Cl<sub>2</sub>, CF<sub>4</sub>/Cl<sub>2</sub>/O<sub>2</sub>, SF<sub>6</sub>, SF<sub>6</sub>/N<sub>2</sub>, SF<sub>6</sub>/Cl<sub>2</sub>/N<sub>2</sub>, NF<sub>3</sub>/O<sub>2</sub>/Cl<sub>2</sub>, etc), it may be possible to achieve vertical profiles, but the selectivity of tungsten to the nitride or silicon oxynitride mask is relatively poor (~1:1). With NF<sub>3</sub>/Cl<sub>2</sub> chemistry, vertical profiles can be obtained with W:Nit selectivity of >2.5:1.

### 2) Vertical tungsten profile:

Or, mask selectivity may be higher (~2:1) with other chemistries, but the tungsten profile may be re-entrant or tapered. Vertical tungsten profiles can be obtained with NF<sub>3</sub>/Cl<sub>2</sub> chemistry.

Other gas additives may be included for added sidewall passivation.

### 3) No CD line gain:

Tungsten profile is vertical, so there is no CD gain or loss.